PRELIMINARY ANALYSIS OF AN INTEGRATED LOGISTICS SYSTEM FOR OSSA PAYLOADS

Volume I
Executive Summary

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1.0 INTRODUCTION

1.1 BACKGROUND

The OSSA Logistics Study commenced in September 1986 with the following tasks: (1) provide a preliminary estimate of the logistics support requirements for OSSA payloads in the Space Station era; and (2) outline an OSSA logistics planning and management system that will provide the required logistics support. Recognition of the importance of logistics to OSSA payloads resulted in the initiation of this study. The importance of logistics centered not only on the ability to support the payloads, but also on being able to afford to support the payloads. Logistics must consider both supportability and affordability. In the past, OSSA payloads did not have to consider support costs. Once they were launched, there was essentially no way to get at them for repair or refueling. In the Shuttle era, payloads are designed for on-orbit maintenance and servicing. Space Station will augment on-orbit support capabilities. Logistics support costs have become a consideration for all OSSA payloads. Historically, operations and support costs have ranged from 40-60% of life-cycle cost for a typical system. Using HST as an example, the operations and support costs are estimated to be $150 million per year. This figure represents 10% of OSSA's current budget. This is just for operating and supporting one payload. This means that the estimated cost for operation and support of HST will amount to 67% of life-cycle costs. With the number of planned OSSA payloads in the Space Station era, affordability becomes the key consideration with logistics

support costs being the driver. This study is the first attempt to come to grips with the logistics support cost burden for OSSA payloads across the board, with special reference to Space Station payloads.

At initiation of this study, a review of other logistics studies was conducted to avoid redundancy with work already completed or underway. The review of other studies revealed that the emphasis had been on determining resupply/return requirements for OSSA payloads in, attached to, or serviced by Space Station. While this information is somewhat useful to Space Station for planning purposes, it does not represent the total OSSA logistics support requirements. The other logistics studies did not address the derived or implied logistics support requirements. The studies identify ORU changeout as a logistics requirement, however, the studies fail to identify the other logistics requirements in the following categories: support equipment; supply support; personnel and training; technical data; packaging, handling, storage and transportation requirements; facilities; and computer resource requirements. The studies focused on identifying the end product without identifying the support pyramid and the system that will provide the support.

The documentation review also consisted of a review of NASA/OSSA level policies, plans, and NMIs. The purpose of the review was to identify any NASA/OSSA logistics policies or plans that would facilitate the development of an OSSA logistics planning and management system. The review of the documentation did not reveal any NASA/OSSA level logistics policies, plans, or guidance.

The initial documentation review set the stage for the study. The major objective of the study was to develop a logistics strategy for OSSA that will lead to the cost effective logistics support of all OSSA payloads. A secondary objective of the logistics study was to develop an OSSA Integrated Logistics Support Planning Document. The purpose of this document was to establish procedures for the preparation of integrated logistics support plans at the OSSA payload program level. This planning document is an initial step in providing logistics guidance to the payload programs.

The approach to the logistics study was briefed to the OSSA Planning Group in November 1986. The approach was endorsed and an additional task was added to the study. The task was to analyze an OSSA payload in development to quantify the benefit of early logistics support analysis in the payload lifecycle. A major subsystem of the Life Science Research Facility, the 1.8 meter centrifuge was chosen as the subject of the analysis. The preliminary supportability analysis of the centrifuge commenced in December 1986 and was completed in March 1987. The preliminary study results were delivered for review in February and March 1987, and the study results were finalized in April 1987. Figure 1-1 shows the logistics study flow and schedule.

1.2 SCOPE

The results of the OSSA Logistics Study are documented in the following four volumes:

Volume I - Executive Summary: The purpose of this document is to describe the logistics study background and approach. In addition, the

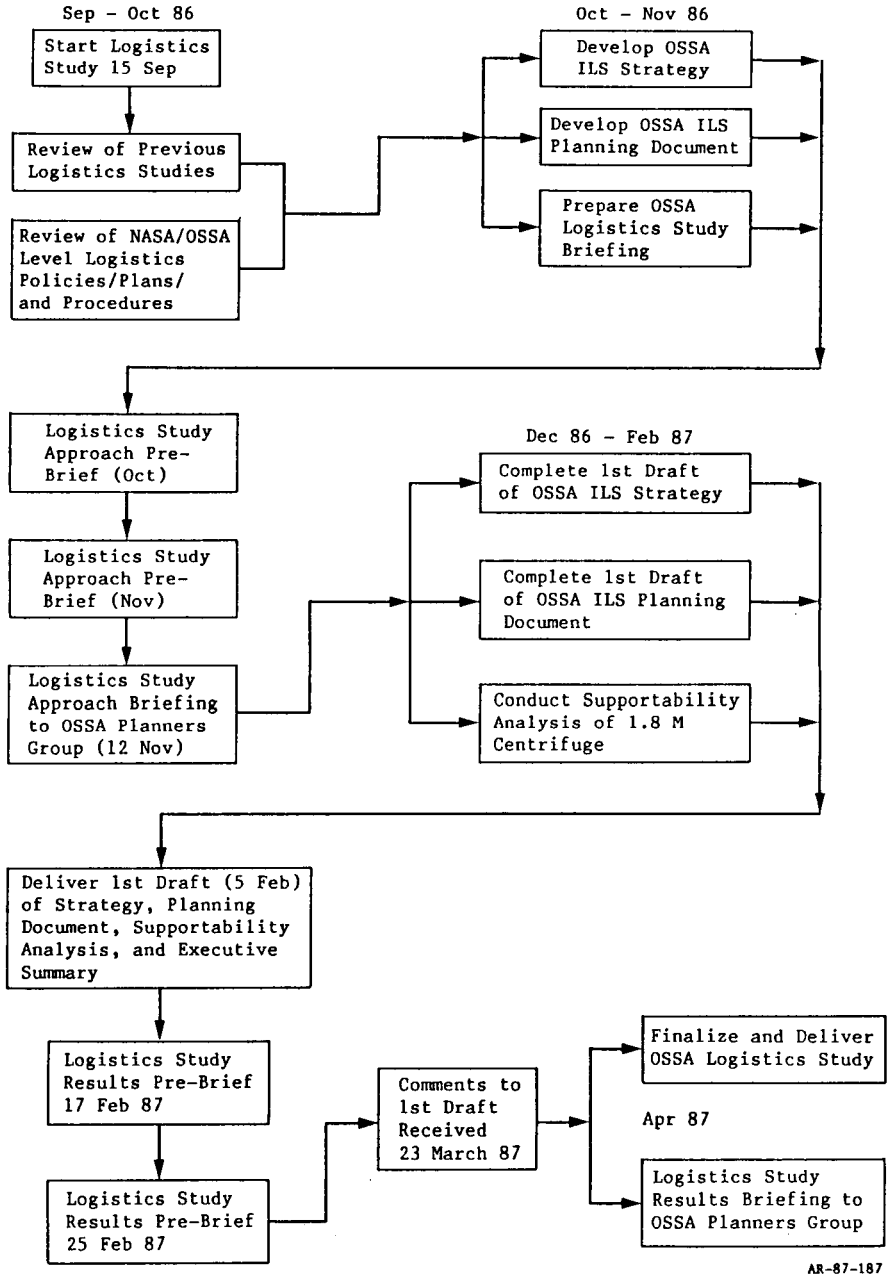

Fig. 1-1 Logistics Study Flow and Schedule

document provides a concise summary of the study results and identifies future logistics support analysis tasks.

Volume II - OSSA Integrated Logistics Support Strategy: This document defines the OSSA logistics strategy, the methodology for implementing the strategy, and the specific logistics tasks that require study and analysis to support the development of an OSSA Integrated Logistics Support Program.

Volume III - OSSA Integrated Logistics Support Planning Document: This document establishes procedures for the preparation of integrated logistics support plans at the OSSA payload program level.

Volume IV - Supportability Analysis of the 1.8 M Centrifuge: This document addresses supportability issues for the 1.8 M centrifuge in the Life Science Research Facility. The analysis focuses on reliability and maintainability and the potential impact on supportability and affordability.

2.0 OSSA INTEGRATED LOGISTICS SUPPORT STRATEGY

2.1 GENERAL

The strategy for integrating OSSA logistics requirements will be to establish an OSSA Integrated Logistics Support Program. Full understanding, concise planning, and common policy and direction for OSSA programs are required to achieve a cost and operationally effective integrated logistics support program. Key to establishing a meaningful logistics program is the initial activity involving the development and communication of basic logistics policies, plans and procedures. These activities form the foundation and provide the common guidance for all OSSA Payload Program Managers in the planning, analyzing, designing, and supplying of logistics services and support resources. The resulting active participation and full communication assures the development of effective interfaces and working relationships, a common base of understanding across OSSA, identification and development of the most cost effective approach, and responsive implementation of requirements.

Specific policies, plans and procedures that will be developed to establish an OSSA Integrated Logistics Support Program are summarized in Paragraph 2.5 of this document. The policies, plans, and procedures will be developed through a series of logistics studies and analyses. The results of the studies and analyses will be documented in an OSSA Logistics Plan.

2.2 OBJECTIVES

The objectives of the OSSA logistics strategy are as follows:

a. Minimize system support and life cycle costs for OSSA payloads.

b. Establish an OSSA integrated logistics system responsive to the support of payload design, development and operations.

c. Integrate logistics across the various OSSA payload programs to ensure that each payload's logistics requirements can be effectively merged into a single OSSA logistics system.

d. Assure visibility at OSSA level over all major logistics activities and resources within the payload programs.

e. Assure that logistics is considered in early design activities to ensure long-term program supportability.

f. Assure acquisition of only those materials, equipment and services necessary by optimizing the use of existing facilities, equipment, capabilities, and hardware from other programs.

g. Ensure the timely availability of required equipment, materials, and services within budget limitations.

h. Assure communication and coordination among OSSA programs, other NASA program offices, and other applicable agencies.

2.3 ORGANIZATION

The establishment and implementation of an OSSA Integrated Logistics Support Program will require the establishment of a functional OSSA ILS organization. Figure 2-1 portrays the organizational relationships for management of OSSA logistics activities. General responsibilities for accomplishment of these activities are detailed in the appropriate section of Volume II, OSSA Integrated Logistics Support Strategy.

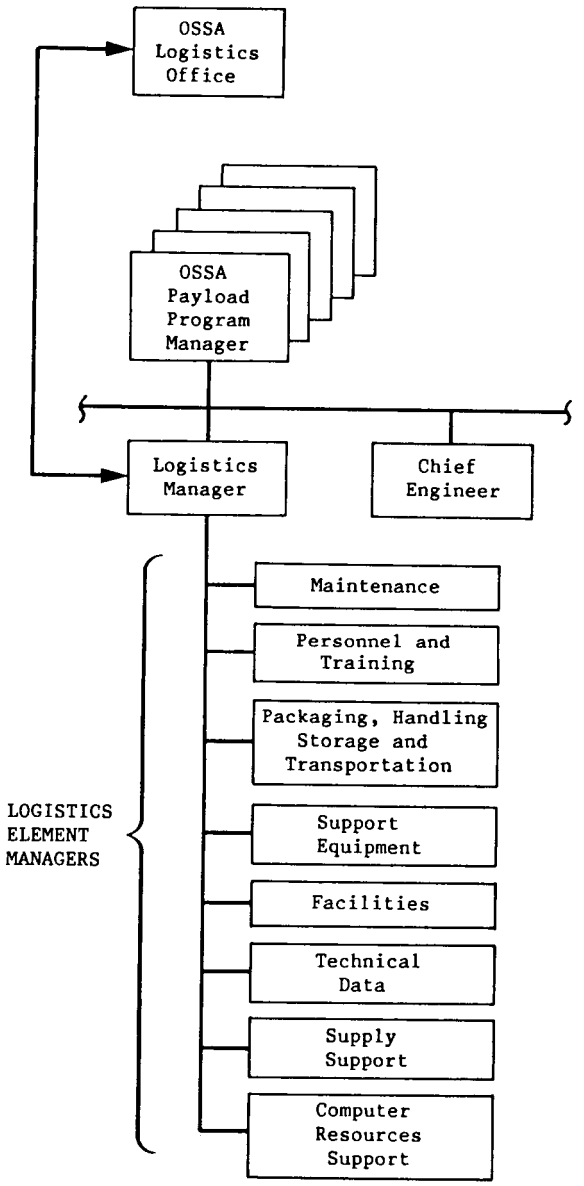

Fig. 2-1 Logistics Organization

2.4 IMPLEMENTATION

Implementation of the OSSA logistics strategy will result in the establishment of an integrated logistics support program for OSSA. Implementation of the OSSA logistics strategy will require conducting logistics analyses, identifying standard logistics procedures, sharing and developing logistics support resources, and establishing programs to reduce the demand for logistics support resources. The strategy will be implemented in phases, with the final objective being a standardized, integrated logistics program within OSSA and across all NASA programs. This integrated logistics program will be able to provide optimum logistics support at minimum cost. Details of the phasing are developed in Volume II, OSSA Integrated Logistics Support Strategy. Figure 2-2 shows the phased implementation of the OSSA logistics strategy.

2.5 COMMONALITY

The key to development and implementation of an efficient, cost-effective OSSA Integrated Logistics Support Program is the definition and establishment of common logistics policies, plans, procedures and support resources within OSSA and other NASA organizations. Commonality within the OSSA logistics program will start with the development of standard procedures for the Logistics Support Analysis (LSA) of all OSSA payloads.

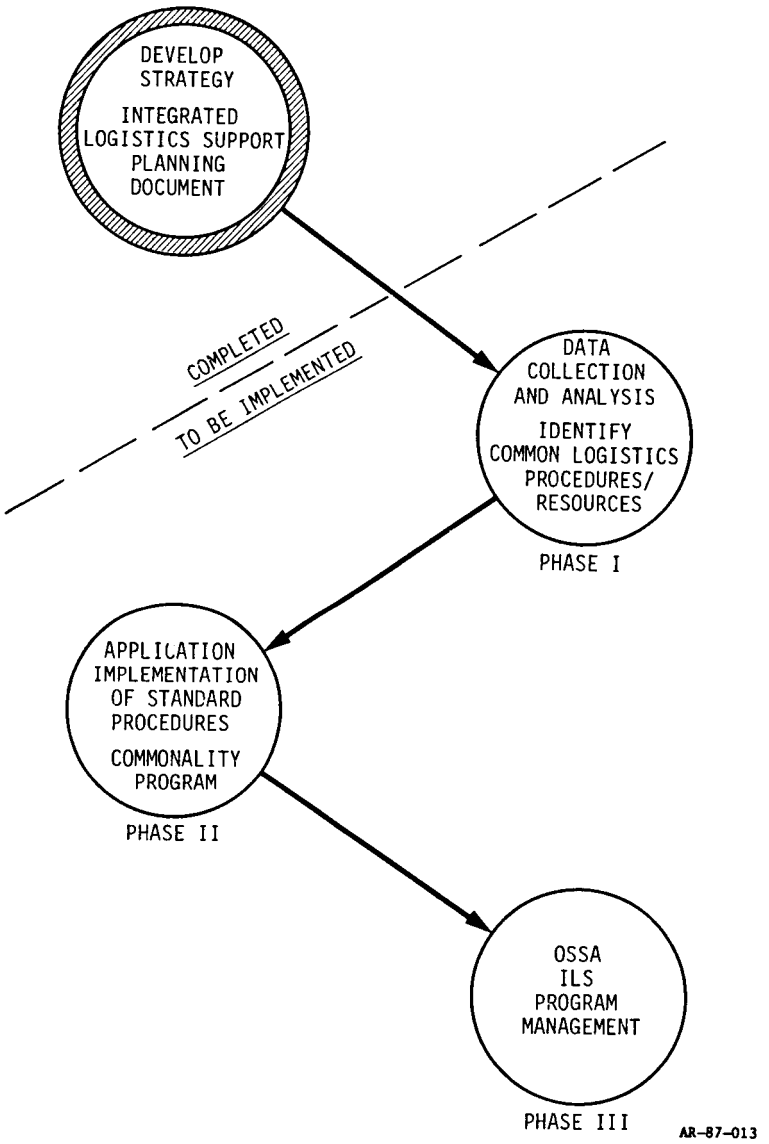

Fig. 2-2 ILS Strategy Implementation Phases

2.5.1 Integrated Logistics Support Plans

OSSA will require, and provide guidance for, the preparation of OSSA payload program logistics support plans. In addition, a review loop at OSSA will be established for these plans. OSSA will formulate a policy statement to implement the requirement for these plans. The key logistics document that will be required is the Integrated Logistics Support Plan. This document is prepared at payload program level to provide the common direction and control required to meet the logistical needs of the program. Guidance for preparing this document is contained in Volume III of this study. Subordinate logistics plans that will also be developed include: the maintenance plan; technical data and documentation plan; supply support plan; logistics facilities plan; packaging, handling, storage, and transportation plan; logistics support personnel and training plan; support equipment plan; and the logistics information system plan. Essential features of these plans are described in Volume II, OSSA Integrated Logistics Support Strategy, paragraph 4.2.

2.5.2 Logistics Information System (LIS)

The LIS is designed to serve as a comprehensive system which will provide real time status of significant logistics activities to determine and evaluate the supportability of OSSA payload programs. The LIS is the key to the coordination of logistics activities within OSSA. Figure 2-3 shows the elements of the LIS; these are detailed in Volume II, paragraph 4.3.

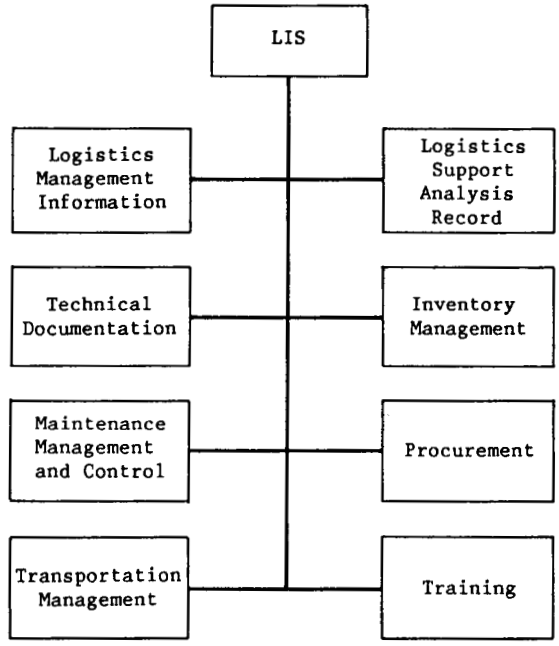

Fig. 2-3 Logistics Information System (LIS) Components

2.5.3 Supporting Activities

There are a number of major supporting activities that must be instituted by OSSA to develop the standard logistics procedures that will ensure an efficient, cost-effective OSSA integrated logistics support program. These activities will be developed through a series of logistics studies and analyses, and include:

- Repair Level Analysis - Establish procedures to determine feasibility and location for repair of ORUs, assemblies, and subassemblies based on life-cycle cost.
- Repair Parts Screening - Establish procedures to prevent entry of items into the NASA inventory that are available in Government inventories. Establish standard part numbers for comparison/integration purposes.
- SMR Coding - Establish procedures for the uniform coding of all support items to convey maintenance and supply instructions to the various logistics support levels.
- Technical Data Packages - Establish procedures for acquisition of required technical data to facilitate repair/refurbishment of support items.
- Facilities - Establish procedures for identifying required/available logistics support facilities.
- Packaging, Handling, Storage, and Transportation (PHS&T) Procedures - Establish standard PHS&T procedures that are the most efficient/ cost-effective.
- Operational Cost Modeling - Establish a single standard operational cost model to predict/minimize cost. Facilitates comparison between programs.

The details for the specific activities that will be developed for commonality application are addressed in detail in Volume II, OSSA Integrated Logistics Support Strategy, Section 4. The results of the logistics studies and analyses will be incorporated into a series of OSSA-level logistics plans.

Conducting the appropriate logistics studies and analyses and developing the OSSA-level logistics plans is the next step in developing and establishing an OSSA Integrated Logistics Support Program. The ILS Program will enable OSSA to come to grips with logistics support costs and ensure supportability of all OSSA payloads. The logistics strategy provides an opportunity to make our Space Science Programs affordable.

3.0 OSSA INTEGRATED LOGISTICS SUPPORT PLANNING DOCUMENT

3.1 GENERAL

The OSSA Integrated Logistics Support Planning Document provides guidance for use in preparing and updating an Integrated Logistics Support Plan (ILSP). It provides clear, concise, and detailed instructions on the preparation and content of an ILSP to ensure a quality document that reflects total ILS program requirements. The ILSP is prepared at OSSA payload program level and describes the payload ILS program in detail.

3.2 PROCEDURES

The payload program manager will draft an ILSP during Phase B and keep it current throughout acquisition. The ILSP will integrate logistics elements of the program. The approved ILSP becomes the ILS program implementation plan for all participating activities. It is included as part of the program management documentation. The latest approved ILSP will be used as a working document by all ILS program participants. The ILSP is the principal logistics document for an acquisition program and serves as a source document for summary information required in other program management documents. The ILSP describes the overall ILS program including requirements, tasks, and milestones for the immediate acquisition phase and plans for succeeding phases. The plan is tailored to the specific needs of each program and will address the total system including the payload, training devices, and support

equipment. The ILSP provides: a complete plan for support of the operational payload; details of the ILS program and its relationship with overall program management; information to decision making bodies on ILS aspects necessary for sound decisions on further development of the system; and information necessary for the preparation of the ILS sections of procurement documents. The ILSP is a dynamic document. It is updated: when new program direction is received; when there are changes that involve personnel, training, facilities, or other ILS planning elements; before key decisions in the system acquisition cycle; when there are major system configuration changes; and prior to development of solicitation documents.

3.3 CONTENT

The ILSP contains the three sections listed below and any necessary annexes. The content of each element is detailed in Volume III, OSSA Integrated Logistics Support Planning Document.

a. Section I, General

1. Introduction
2. System Description
3. Program Management
4. Applicable Documents

b. Section II, Plans, Goals, and Strategy

1. Mission Need Statement
2. Acquisition Strategy
3. Logistics Support Analysis (LSA) Strategy
4. Supportability Test and Evaluation
5. ILS Element Plans

c. Section III, ILS Milestone Schedule

d. Annexes (as applicable).

4.0 SUPPORTABILITY ANALYSIS OF THE 1.8 M CENTRIFUGE

4.1 GENERAL

The supportability analysis of the 1.8 M centrifuge in the Life Science Research Facility focuses on reliability, maintainability, and commonality considerations in system development and their potential impact on supportability and affordability. The analysis outlines standard logistics engineering methodologies that are employed to incorporate integrated logistics support planning into the early phases of system development in an effort to influence design and reduce future logistics support requirements.

The Centrifuge is but one of four or more specimen holding and management equipment items which will be closely integrated to form the heart of the Life Sciences Research Facility. Centrifuge designs exist only as conceptual designs at present, but specific logistics concerns have already surfaced in the areas of reliability, maintainability and commonality.

4.2 RELIABILITY

The supportability analysis of the centrifuge examined the subsystem relationships. One area of concern was the series relationship of nine components of the centrifuge with no built-in redundancy. Even if these components were designed for a life of 25 years with no failures, the resulting system Mean Time Between Failure (MTBF) would be 2.8 years. If the components have a

more realistic lifetime of 4 years, the resulting system MTBF would be less than 180 days. Component redundancy will be crucial to mission success for the 1.8 M centrifuge.

4.3 MAINTAINABILITY

Maintainability is a key design consideration for the 1.8 M centrifuge. All critical components within the centrifuge will be functionally packaged and designed as ORUs. The centrifuge will incorporate BIT/BITE to isolate failures to the ORU level. On-orbit repair of centrifuge ORUs will be analyzed. If centrifuge ORUs are chosen for on-orbit repair, then they will be designed to be tested with test equipment that is available on the Space Station. Test equipment will isolate failures to the subassembly level, and spares will be available on the Space Station. The capability to replace failed ORUs while the centrifuge is operating will also be considered. Location of spare ORUs will be analyzed in conjunction with required/available on-board storage space. Other maintainability considerations are training and technical data requirements. These considerations will be applied to all candidate subsystems and incorporated as design requirements. A specific example is the ball bearing suspension system that has been chosen as the leading option for the suspension system. The ball bearing system requires that its oil system be serviced at a 5-year interval. The logistician will assess the impact on support equipment requirements, skills required to perform the servicing, time required to perform the tasks, and contamination or other hazards involved.

4.4 COMMONALITY

Commonality in design will be emphasized to reduce logistics requirements and cost. The current centrifuge concept requires three drive motors, one for each of the rotors: the main rotor, the service rotor, and the compensator. Each motor is different due to different torque requirements. No motor redundancy is planned. Designers should look at the possibility of common motors. Commonality of design should also be considered for the power transformers and optical couplers. All standardization achieved will improve supportability of the centrifuge.

Intensive supportability analyses paralleling, and coupled with, Phase B 1.8 M centrifuge system definition and preliminary design studies will penetrate these and other potential problems in detail. They will provide the program manager with logistics planning tools to ensure the successful development and operation of the centrifuge. If, as seems likely, NASA develops the core group of specimen habitats, centrifuges, a multipurpose workbench, specimen husbandry devices and equipment cleaning hardware as a single development entity, then simultaneous, integrated, in-depth supportability analyses of these payload elements will constitute an essential early step in the Life Sciences Research Facility program.

5.0 SUMMARY

5.1 GENERAL

The OSSA Logistics Study has developed an OSSA Integrated Logistics Support Strategy. The strategy involves the establishment of an OSSA Integrated Logistics Support Program. The major objective of the ILS program is supportability of all OSSA payloads at an affordable life-cycle cost. Establishment of an OSSA ILS program and accomplishment of this objective requires a firm commitment from OSSA. This commitment requires establishing an OSSA logistics policy and an OSSA level logistics organization. Implementation of the OSSA logistics strategy is time-sensitive and will require close coordination with the Space Station Program and other NASA programs.

The OSSA Integrated Logistics Support Planning Document establishes standard procedures for preparing Integrated Logistics Support Plans (ILSPs) at OSSA payload program level. Standard ILSPs will ensure common direction and control of payload logistics programs.

The supportability analysis of the 1.8 M centrifuge was a preliminary look at some of the key supportability issues. This document shows the importance of early ILS planning in system development. The decisions made now, for individual pieces of equipment or for all OSSA payloads, will dictate

future support requirements and costs. These requirements and costs can be minimized through an effective Integrated Logistics Support program.

5.2 FUTURE NEEDS

The future need for additional logistics studies, analyses, and plans were discussed in detail throughout the study, but can be summarized as follows:

- Establish an OSSA logistics policy.
- Develop an OSSA level logistics plan.
- Conduct logistics studies and analyses to establish common procedures in the following areas: logistics information system; logistics support plans; repair level analysis; repair parts screening; source, maintenance, and recoverability coding; technical data packages; facilities; and packaging, handling, storage, and transportation.
- Conduct supportability analyses for all OSSA payload hardware.
- Develop Integrated Logistics Support Plans for all OSSA payloads.
- Coordinate all actions for integrating the logistics support of all OSSA payloads.
- Establish a single point of contact for OSSA logistics and the interface with SSP and other NASA organizations.